E/CONF.39/D/133
20 Nov.1962
ENGLISH
ORIGINAL : SPANISH

UNITED NATIONS CONFERENCE
ON THE APPLICATION OF SCIENCE AND TECHNOLOGY
FOR THE BENEFIT OF THE LESS DEVELOPED AREAS

Agenda Item : D

Argentina

STRUCTURAL PROBLEMS OF INDUSTRIAL DEVELOPMENT AND THE POLICIES OF PROMOTION

By Adolfo DORFMAN

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STRUCTURAL PROBLEMS OF INDUSTRIAL DEVELOPMENT AND THE POLICIES OF PROMOTION

By

ADOLFO DORFMAN (x)

1. The countries of Latin America are going through a process of structural change which takes the form of the diversification of cattle raising, agriculture and mining, which were the mainstay of the old structure, and a new emphasis on industrial activity. The scope and reach of these changes vary from country to country, but commerce is usually the sphere in which the greatest changes occur, as the bare subsistence level of production and consumption is only slightly affected and may remain in some cases untouched by the transformations occurring elsewhere. Nevertheless, the social and institutional impact is very great. The differences to be found in their present day productive activities are fundamental and can be seen in low coefficients of capitalization and mechanization per unit of product or man employed (whether land worker or craftsman) and in outmoded working methods resulting in a large labour force and low output. The problem is, therefore, partly one of technology and partly one of investment, and spreads over the spheres of capitalization and operation. It is in these sectors that maximum potential growth of Indo-America's domestic markets lies both because of its large population and its present low levels of productivity and consumption. The chances of obtaining a quicker return from marginal investments in agriculture and crafts would be good, were it not for the need simultaneously to invest large sums in the rudimentary economic and social infrastructure in which the ratio of return to outlay is very low and the time taken to mature a long one. Thus inequalities of income and forms of production are formidable obstacles to industrial progress. To overcome them is a very difficult, costly and slow process which will yield no significant short or medium term returns.

2. The structural changes mentioned began to take place in 1940 in some of the more developed countries of Latin America, gathered momentum during the war and have continued since with fluctuations. Moreover, they are now appearing in countries which hitherto lacked industries or in which industrialization was in its infancy. It is thus possible to study the development of industrialization over a quarter of a century in countries faced with different internal and external situations and pursuing different economic policies, whether or not government controlled. The various stages of this process can be classified and related to determining factors.

(x) The author is an official of the U.N. Economic Commission for Latin America, but the views expressed here are his own. Owing to limitations of space imposed by the rules of the present conference, his treatment of some problems is extremely brief and in bare outline. Certain relevant topics had to be omitted.

3. A few words must first be said about crafts and craft occupations in town and country. Their incidence varies in the different countries, and they mark the transition to an industrial age. At one end of the scale there are countries such as Argentina, Uruguay and Brazil, and at the other Ecuador, Bolivia, Peru, Colombia and El Salvador. Among the former 10 to 15% of the employed are engaged in craft occupations, whilst among the latter with their large Indian element the majority employed (50 to 80%) are so engaged. The indices in respect of the value of handicrafts are somewhat lower. Non-industrial craft work in the towns is in part merely a transplantation of rural crafts and is to a much greater extent a reflection of the spreading out of auxiliary industrial work and personal services in towns to home-workers. Apart from traditional weaving and pottery, there are numerous small workshops and repair shops lacking modern machinery and capital. Consequently, one of the features of "industrial" development in many countries, viz. the prominence of crafts and craft occupations, has deep social and economic roots and poses major problems with regard to the rationalization of the industrial structure by the organization of bigger and more efficient operational units.

4. Since before the war, the contribution of manufacturing industries to the gross national product has been growing in Latin America: from an average of 12% it rose to 21% by 1960, and rose no higher than this because of backwardness in some countries. In the same period, the increase in industrial output was double that of other sectors of production. The three countries which together account for more than two-thirds of Latin America's total industrial output concentrate more than 21% of their respective gross national product in manufactures. The remainder come lower down the scale up to less than 10%. With this marked increase in the output of the industrial sector, which is accompanied by a relative (and sometimes absolute) fall in agricultural and cattle raising output, the internal industrial structure of the more advanced countries shows signs of maturity. By 1940, over 60% of their gross national product was derived from non-durable consumer goods, such as foodstuffs and clothing, and by 1960 the proportion was 45%. Meanwhile, chemicals and metals rose from a mere 20 to 25% to 40%, the larger share going to the heavy industries in these categories. For Latin America as a whole, the proportion of the two groups is now probably just over 50% and 30% respectively.

5. Industrial production in Latin America rose by 80% between 1950 and 1960, but while consumer goods rose by 40% (keeping in step with population growth), heavy and semi-heavy industries rose by 100%. Thus growth of industrial production outstripped that of domestic consumption in the same period, and this was largely due to less dependence on imports. By 1960, the structure of production in the more industrialized group of Latin American countries was approximately as follows: consumer goods 50%, unfinished goods 40% (barely half of which were metal goods and chemicals), and capital goods 10%. In Latin America as a whole, heavy and semi-heavy metal goods and chemicals for the home market account for no more than 15% of industrial output. Only one-third of the output of the chemical industries takes the form of unfinished goods, one-third of which are in turn basic materials. To appreciate these trends it must be remembered that in Mexico between 1950 and 1960, manufactures of non-consumer goods increased three times faster than manufactures of consumer goods, and in Brazil twice as fast as in Mexico.

6. To understand the structural aspects of these changes better, one must analyse and compare the changes that have been taking place in the pattern of Latin American imports. In the last 20 years, in relative terms, imports of consumer goods fell to less than half, whilst imports of unfinished goods were doubled and imports of machinery and plant rose by 50%. Fuel imports remained stationary. The figures are respectively: from about 50 to 20% for consumer goods; from over 20 to over 40% for unfinished goods; from over 20 to 30% for capital goods; and 10% for fuels. Among the imports of consumer goods the greater share went to non-durables, since durables are brought in mainly as parts or components for assembly or processing after entry. Among the unfinished goods imported it is necessary to distinguish between (a) simple materials such as natural textile fibres and cement (domestic production of which is rising rapidly with the spread of industrialization); (b) semi-finished metals and basic chemicals (typical of the intermediate stages of industrialization in which processing industries depend to a very marked degree on such imports); and (c) metal components and more complex chemicals (characteristic of a more advanced stage of industrialization). Among the non-consumer goods, machinery and industrial plant represent 60% and vehicles 25% of the total.

7. The well-known phenomenon of urban growth is associated with industrialization, and this from the point of view of development, implies a concentration of basic services and production in centres of local expansion. From before the war to 1960, urban population in Latin America rose at about twice the rate of rural population, though rather unevenly from country to country. This fact reveals the massive flight from the country to the towns: between one-third and two-thirds of urban population increase stems from causes other than natural increases. Whereas before the war barely 35% of the population was urban, the proportion had by 1960 risen to over 45% and nearly half of this number lived in cities of over 100,000 inhabitants.

8. Generally speaking, in those countries with a relatively small domestic market which have more recently embarked on an industrialization programme production of consumer goods, and more especially non-durables, takes pride of place. The other categories of production are almost completely absent, and this is true particularly of Central America, Ecuador, Uruguay and Bolivia. In the older industrialized countries, however, there is a certain emphasis on the production of capital goods and semi-manufactures. Light industries have thus become a more organic part of the structure. They give rise to the demand for unfinished materials and plant, and are themselves the product of growing home demand. Three phases may be distinguished:

(a) Following a considerable increase in light industries, completion of 'backward linkage' there comes a period marked by the establishment of heavy industries producing unfinished materials (especially metals) and the partial production of some plant and vehicles (Brazil and, to a lesser extent, Mexico).

(b) Similar to the above, but with this important difference, that industries producing basic materials have declined with serious effects on the balance of payments (as in Argentina).

(c) Less growth and consolidation of light industries and continued reliance on imports of unfinished materials,

despite a slight expansion in agriculture (Colombia); nevertheless, production of basic materials for a small domestic market is being encouraged relying, as in the case of Chile (iron, steel and paper), on export markets.

9. On top of all this, certain features that arise from qualitative and quantitative differences in the distribution of natural resources must be regarded as a basic factor of industrialization and its problems. In the period under examination certain changes have also taken place in this sector, partly as a result of industrialization and partly as a result of external demands. A typical case of abundant agricultural and livestock resources is to be found in Argentina, where obstacles to the establishment of light industries were overcome without much difficulty. The trend towards the heavy mining industry is of special importance in the present stage of structural consolidation. Iron and steel manufacture is more easily established in those countries which, like Brazil, Chile, Peru and Venezula, export iron ore since the diversion of part of the output to the home market presents no problem). Mexico is a special case: an iron and steel industry has been set up there, even though Mexico is not an exporter of ore, whereas Argentina imports ore etc. for its iron and steel industry. In any case, geographical location will be subordinated to a number of factors such as power supplies, technology, overheads, which determine the optimum choice. The tendency even in countries which are not oil-producing, to refine the greater part of the oil locally consumed, is now widespread throughout the world; and in Latin America, too, refineries are being set up. Different situations arise according to whether countries have their own oil resources, which need not be a decisive factor; or whether they are large exporters of oil (Venezuala, Colombia and Mexico); whether growing domestic demand has outstriped new oil finds (Ecuador, Peru and Bolivia); or whether partial production obtains (Brazil and Chile), but Argentina is the outstanding exception.

10. In short, four characteristic situations may be reached in countries in process of industrialization; (a) A relatively balanced development of industry, cattle raising and agriculture (possibly at low and medium levels, helping 'backward linkage' or following an independent course); (b) Industrial growth at the expense of agriculture; (c) Excessive growth of consumer goods production, accompanied by a disproportionate rise in imports of semi-finished and capital goods; and (d) Growth of basic industries harmonizing to some extent with growth in the consumer goods sector.

11. Industrialization begins, as is natural, with the simpler technicological operations that involve less density of capital per unit of product or operative. Production is concentrated on those consumer goods for which there exist big, ready-made home markets, the growth of which is favoured by the rapid urbanization taking place in Latin America.

The possibilities of this easy and inexpensive method of substituting local products for imports are soon exhausted because of the relative smallness of domestic markets even in those countries with the highest national income. The next stage, some phases of which may seem rudimentary or even more advanced, is reached simultaneously with the expansion of light industry. In many countries the first

stage is prolonged, without passing the point at which it would have been economic. Nevertheless, it represents a step forward for the national economy, even though earnings from exports are largely offset by increased imports of semi-finished goods and capital equipment. Much depends on production cost structure. Where manpower is abundant, as is generally the case, and some of the raw materials are available locally (foodstuffs and textiles), not only is a greater degree of industrialization achieved with greater opportunities of productive employment, but also an easing of the balance of payments situation. This is similarly true of the terreous building materials sector. In the case of durables, however, the picture changes: here the requirements of basic materials and machinery (and thus directly or indirectly, imports) will be considerable, and income less than the cost of importing the final product.

12. Thus disequilibrium often arises between industries making finished products and those producing unfinished materials. The result has been so far that the greater part of the imports of the countries in process of industrialization consists of unfinished materials, fuels and capital equipment. These were always imported in large quantities, however, except that previously they were required mainly for public works (transport, and urban engineering) or mining, whereas nowadays they provide a stable base for industry. Therein lies the dynamic difference between the two periods, and their strategic effects as well. If a country with limited foreign currency reserves were unable to import the necessary quantities of plant and unfinished materials, its industrial activities would grind to a halt, with serious repercussions on supplies and employment. The industrial structure continues to expand, but at the same time its external vulnerability increases as transitional practices continue. Hence the importance of its consolidation, completing the intermediate stages and correcting disequilibrium wherever possible.

13. The dynamics of industrial development reveal features which vary according to the original impetus, the characteristics, structure and trends of the domestic market, and the manner of satisfying home demand. It follows that the process of industrialization tends to be associated with the substitution of local products for imports (actual or potential), and the course it takes will be clearly marked by stages peculiar to each case. Typically, four main stages of industrial establishment may be distinguished: (a) 'backward linkage' or towards original impetus, (b) 'forward linkage' with rising industrial demand, (c) radial expansion through growth of auxiliary industries, and (d) heavy industry.

(a) The manufacture of light consumer goods (durable or not) very often continues for years without going beyond the most elementary processes. It is geared to market requirements for the final product, and the firms concerned are generally capable of large-scale production, but their technology is not very involved, and capital investment per operative is moderate or relatively low. The

substitution cycle begins with industry using mainly farming raw materials, for those industrial activities (such as foodstuffs and clothing) which are more truly representative of the early stages of industrialization, or unfinished materials for assembly or production of consumer durables. Of course, this process does not recur with the same regularity or in the same sequence in all industries: in some it may begin with a more advanced level of manufacture than in others; or, two or more consecutive phases of the process may occur almost simultaneously. The important thing is that the switch to home production stops when farming products cease to be available locally, or when the immaturity of its industrial structure (or the smallness of the domestic market) prevents the manufacture on an adequate scale of certain unfinished materials, mainly metals and chemicals. In other words, those activities depend to a fair extent on imports of unfinished and raw materials. Thus the problems of integrated growth and the substitution of local production for imports are merely shifted to a different plane without being solved.

(b) As regards the manufacture of capital goods, such as machinery and plant, its introduction is to some extent the opposite of the case just described. It is based on the prior existence of certain semi-heavy industries, and its products are geared to industrial demand and the needs of other sectors of the economy. In this case, the substitution cycle begins with mining or other industries and requires major capital investment, a scale of production often in excess of the capacity of the local market in an underdeveloped country, complex technology (special or high-precision machinery) or simpler, almost traditional techniques (mass produced machinery and plant). From a point of view of industrial chronology, it calls for a more developed industrial and economic structure, capable of producing a sufficiently large and varied demand for such capital goods and justifying the setting up of heavy industries producing unfinished materials.

(c) The third class consists of industries supplying components for the use of similar industries, viz. engineering products and chemicals. Industries of this type only arise when those to which they are complementary have reached a fairly advanced stage of development. Thus, for example, engineering industries are complementary to the motor vehicle, tractor and machinery industries which require thousands of different parts or components, all mass produced in more or less regular quantities. Heavy chemicals appear at an even more advanced stage of industrialization, to supply firms making such traditional products as textiles, paper and

soap in early stages. They interlock with other industries and exist not so much for particular manufacturing processes as by virtue of the dynamism and vitality of the industry as a whole.

(d) Finally, the fourth class constitutes, directly or indirectly, the basis for the development of the three others and the entire industrial structure. It comprises industries making heavy unfinished materials (metals and chemicals) and its establishment forms part of the cycle. These industries require major investments and their technology can be quite complex (cement, traditional iron and steel, special alloys, synthetic chemical products). Mining completes the cycle.

14. Like every brief analysis, this last one suffers from omissions and may appear mechanistic. To avoid misunderstandings, it must be pointed out that the real sequence of stages and phases in their intricate connections is very complex and distinctive when seen in the dynamic reality of each country and period of history, and naturally depends on the magnitude and structure of national income, natural resources, technology, demography, government policy, etc. However, the general lines of this analysis are not thereby invalidated and do reveal the general structure of the process of industrialization.

15. Here are some examples of the steps by which industries representative of each group have grown up (importing and manufacturing stages being linked):

(a) i. Non-durable consumer goods: edible oils (seeds); clothing (cloth, spun goods, fibres); drugs and medicines (bulk imports of ingredients, partial manufacture);

ii. Durable consumer goods: paints (industrial oils, pigments); household electrical equipment, such as radios, refrigerators, etc. (parts imported for assembly, and subsequent partial or total manufacture locally).

(b) Miscellaneous equipment and installations for industry, mining, construction, etc; and vehicles: some parts imported for local assembly, others made locally (similarity of development in each case), until the process is completed in some cases (machine parts, auxiliary electrical plant, wire and cable, tyres (or rims) and semi-finished metals).

(c) The auxiliary engineering industries are grouped around the production of the goods in class (b) above, for which they supply various parts; the auxiliary chemical industries, strictly speaking, belong to class (d),

since they supply basic ingredients to other industries (alkalis, acids, petrochemicals).

16. The difference between the demands analyzed above is sufficiently clear in the early days of industrialization. As time goes on, however, it grows less perceptible because of the increasing dependence of traditional industries on synthetic materials (altering the industry-agriculture cycle to an industry-synthetics cycle) whereas the more dynamic manufactures, such as consumer durables, create increasing demands for semi-finished metals. Moreover, the increasing automation and mechanization of light industries results in a greater need for capital in relation to labour, and also in relation to production cost, but to a lesser extent. Hence the appearance of a greater number of more complex industrial connections and increased dependence on imports (especially textiles), even though domestic production of raw materials is adequate (wool and cotton). The same is true of paints: natural mineral pigments give way to synthetic anilines, and vegetable oils to lacquers. The case of natural and synthetic rubber, is somewhat similar although here - owing to the fact that almost every country imports natural rubber, whilst domestic production of synthetic rubber is spreading thanks to petrochemicals - the position is to some extent the reverse of what has been observed in the case of natural and synthetic fibres.

17. The distinctive characteristics of the four industrial classes are shown in the following table (see page).

18. Thus, whatever the original impetus to the substitution of home-made products for imports, whether of consumer or capital goods, and the commencement of industrialization, the process generally stops at the production of chemical and heavy metal goods which are essential to its processes. This is reflected in changed patterns of imports in which unfinished materials assume increasing importance. If it occurred simultaneously throughout the whole of industry, the result would be a uniform and continuous increase in imports of materials in a progressively less advanced state of manufacture. This is not of course in fact the case. In the complex constellation of industries, the degree to which they are nationally integrated, their characteristics and establishment dates, all vary considerably and their import requirements just as much. Consequently, at any given moment, whilst one class of home-made articles reaches the limit up to which it can replace imports by now importing only raw materials, or no materials at all, others move into intermediate positions with the result that a certain proportion of consumer goods (relatively less as industrialization progresses) and a wide range of materials of varying degrees of manufacture are imported. Simultaneously, machinery, plant, vehicles and components, are brought in on an increasing scale. The final outcome of these developments is a trend toward increased imports of materials of a minimum degree of manufacture (with more complex materials tending to predominate) and components of capital goods particularly the most specialized kinds.

19. This change to a new pattern of imports raises new problems of supply bottle-necks, the growing importance of indirect imported

components, new cost structures for a different stage of production, effects of remittances of profits on net gains to the balance of payments, etc.

20. An attempt has been made to relate the factors of industrialization and the replacement of imports in a diagram and a graph (not included here for the sake of brevity). The diagram is arranged in columns showing the four classes and sub-classes, and in each column are listed types of unfinished materials and plant required, whether locally made or partly imported. In the graph, finished and unfinished products are indicated by ordinates and abscissae. Families of curves (one for each branch of industrial production) their growth and varying dependence on imports. Because of the unpredictable and manifold uses that can be found for the main types of industrial products (basic unfinished and capital goods) and which increase with progress, the inter-dependence of the main sectors of industrial production and imports during the various stages of industrialization is inevitably sketchy and not easily pinpointed.

21. Some important conclusions emerge from the foregoing analysis:

(a) Industrialization begins with intensive substitution of home-made light goods for foreign imports, and a consequent increase in imports of essential semi-manufactured goods and the plant for manufacturing these.

(b) Recent industrial expansion is not the end of 'backward linkage' but stimulates a demand for complementary imports.

(c) Immaturity of the industrial structure leads to vulnerability when the supply position is critical.

(d) Consequently, heavy industry is the critical sector of convergence, whether as regards integration of consumer goods production or more highly specialized production.

(e) In countries where a certain level of industrialization has been attained, but where there is an adverse trade balance, heavy industry at once solves the problem of supplies, of integration of the industrial structural base, and of balance of payments.

(f) The need for an integrated, coherent and homogeneous approach to the industrialization process as an essential basis for a rational, efficient policy of promotion is confirmed.

22. In that process, the governments of Latin America reserve for themselves either exclusive control of, or a major share in, certain basic or strategic sectors which are generally: strategic military industries, electric power, mining and oil refining, iron and steel, and some chemical industries. The degree of state participation varies according to industrial sector, country and period of history. This

also happens in some Asian countries, where state enterprise accounts for between 20 and 40% of total industrial and mineral output. Heavy industries are prevalent only in a few cases, as in India, where a twenty-fold expansion between 1950 and 1965 is expected as a result of large-scale state participation. In the same period industrial production is to be trebled, and state participation will be increased from 5 to 25%.

23. In Latin America, public financing of the basic energy sectors (electricity and hydrocarbons) has increased a great deal since before the war. The same is true of basic industries, particularly iron and steel and some chemical industries. Apart from these, however, state-owned industry plays a very small part, and a diminishing one at that during the last five years of expansion of private enterprise. Public investment in industry as a whole was of the order of 10% in Argentina and Chile, and 5% in Brazil and Mexico. In nearly all cases this was mainly in oil refineries and iron and steel, with a variable share in other industries.

24. By 1960 state enterprises in Latin America (excluding Venezuela) were producing three-quarters of the crude oil, and refining an even larger proportion, for domestic consumption. Ten years earlier, the figures were about half of this. In absolute terms this means an increase of over 300% in state oil production. In the sphere of electricity, installed capacity of state power stations rose from 15% of the total in 1946 to 60% in 1962, and state power stations are spreading everywhere in Latin America. They accounted for 5% and 50% of distribution over the same period. Iron and steel undertakings financed wholly or in part by governments, whilst small in size at the end of the war, now account for more than three-quarters of pig iron and over half of the rolled steel output, and are to be found in all the large and medium-size countries of the continent. The state plays a much smaller part in the production of basic chemicals (perhaps a quarter or a fifth) and does not even account for a tenth of total output of machinery and vehicles.

25. Where are the funds for industrial expansion in Latin America to come from ? This is one of the fundamental problems of development because possible conflicts with other sectors of the national economy (overlapping and balance) loom larger. In those countries in which this problem appeared in a more acute form (mainly Argentina and Brazil) similar methods of transferring public funds were followed. In both cases industrial expansion (exports especially) was subsidised implicitly at the expense of farming, and foreign exchange policy favoured industry. Financial aid to industry has been quite intensive, and takes the form of direct public investment or a considerable inflow of credits (domestic and foreign). Thus, for example, in Argentina and Brazil by 1960, the proportion of bank loans to industry was more than 40% of total, as compared with 30% and less before the war. This was a period of high industrial profits. It is difficult to estimate their magnitude, but there is indirect evidence, e.g. the high incidence of self-financing in industrial expansion in Argentina and Brazil, and the high proportion of foreign capital re-invested in industry.

26. A country in process of development cannot fail to be faced with

the task of reconciling partly conflicting aims. Consequently, in order to achieve the best results from its industrial development policy, to obtain maximum benefit, its approach to the problem must be co-ordinated and single-minded. It is vital that a country should possess a development organization which, after complete analysis and diagnosis of the situation, can view as a whole the different aspects of the industrialization process and take positive measures to build up the industrial structure without falling back on "protectionism" and "prohibitionism", which are now standard practice in many countries.

27. In the early days, industrial development policies were haphazard, local or specific, without any attempt at functional and integral co-ordination. This is still the case in many Latin American countries. Even when there are policies of economic development, they do not include industrial promotion. Regional development (provincial or federal) is unilateral and not in accordance with any valid plan. The promotion of industries within a given sector is generally based on their use of local materials or, as in some cases of strategic importance (iron and steel), their contribution to foreign exchange, etc. An unimaginative development policy follows a familiar course: protection mainly and essentially by tariff barriers, or exemption from taxes. When widely applied, it loses any incentive value it might have had as regards the siting of new industries and the type of goods produced. As a result, and despite general awareness that industrial development must be planned, it has been inorganic, its measures conflicting and costs higher than necessary.

28. No country in Latin America so far possesses the kind of organization envisaged above. At the most, there is a vague plan of industrialization, but the necessary instruments have not been simultaneously adopted to carry out the plan within these basic concepts. Usually, there are separate plans for promotion of the different branches of industry, and no attempt is made to judge their effects on the rest of the economy. Too frequently only the quantitative aspect - volume of production - receives attention. In few cases, perhaps even none, consideration is given at the same time to the social cost which, if it were excessive, could make the whole process of industrialization uneconomic.

29. To investigate the results of industrial development policy, it would be necessary to know the magnitude and effects of the various measures taken to implement it in each branch. Such an analysis would provide a valuable yardstick by which to judge the best methods of meeting specific needs and the intensity, duration and timeliness of their application. It is almost certain that fundamental objectives can be achieved with the greatest economic advantage to the community without recourse in every case to all the proposed measures of development. A careful selection of those which will ensure the most efficient use of the factors of production is therefore essential. We feel that there are in many countries enough experts to formulate this type of industrial development policy, and they must accept the idea that development is a succession of organically linked phases during which the timely and selective establishment of key industries (for example, essential unfinished goods and some capital goods) takes place, giving

momentum to the process and ensuring its optimum propagation.

30. To avoid misunderstanding, it must be pointed out that these views have nothing to do with outmoded standards, whose strict mechanical application would leave the less developed countries beyond the reach of all industrialization, especially heavy industry. What is suggested here is that the industrial process should be integrated, as and where suitable, by the establishment of a basis of heavy industry, but so as to produce optimum results with minimum costs.

31. To sum up: unlike earlier periods, this is a time when governments are beginning to embark on policies of the deliberate promotion of industry. However, none has succeeded in drawing up a totally congruent, integrated and rational structure, although general and specific instruments of great usefulness have been forged. Conflicts have arisen between policies at different levels and in different spheres, many still unresolved, thereby mutually mitigating and nullifying their advantages. To achieve maximum efficacy in the economy as a whole and in each sector, these policies must aim at overall compatibility, maximizing profits and harmonizing economic and social aims, national and regional aims and general and industrial aims. In this process, positive policies of development must be founded inter alia on inter-industrial and regional integration (based on the rational siting of industrial and economic complexes).

	Consumer goods			Auxiliary industries		
	Non durable	Durable	Industrial goods	Engineering	Chemicals	Unfinished products
Industrial stage	Incipient	More advanced	Advanced	Advanced	Advanced	Very advanced
Capital - density	Less	Average	More	Average	More	More
Labour - density	More	Average	Less	Average	Less	Average
Techniques	Known & simple	Average complexity	More complex	Average complexity	Very complex	Complex
Specialization	Relatively little	Rather more	Considerable	Average	Very considerable	Considerable
Dependence on imports of unfinished materials	Average	Great	Great	Great	Variable	Very little
Foreign technical and financial participation	Not needed	May be needed	May be needed	May be needed	May be suitable	May be suitable
State participation	Not needed	Not needed	May be needed	No	May be needed	Yes
Special measures of assistance, or technical assistance	Not needed	Not needed	May be needed	May be needed	Yes	Yes

916 E - Nov.1962 - 1,600

E/CONF.39/D/133
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ORIGINAL : SPANISH

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By Adolfo DORFMAN

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INDUSTRIAL DEVELOPMENT POLICIES AND PROBLEMS OF STRUCTURE

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ADOLFO DORFMAN

1. The countries of Latin America are going through a process of structural change which reveals itself in the diversification of agriculture, cattle raising and mining, which were the mainstay of the old structure, and a new emphasis on industrial activity. The scope and reach of these changes vary from country to country, but usually commerce is the sphere in which the biggest changes occur as the bare subsistence level of production and consumption (which is so widespread in regions of native extraction) is only slightly affected and may remain in some cases untouched by the transformations occurring elsewhere. Nevertheless, the social and institutional impact is very great.

2. By 1940 these structural changes were already noticeable in some of the more developed countries of Latin America and, gathering momentum during the war, have since continued with fluctuations. Moreover, they are spreading to countries which in 1940 either had no industrial set-up or one that was in its infancy. The contribution to gross national product of the manufacturing industries in the Latin American countries rose from an average of 12% pre-war to 21% in 1960.

3. Signs of maturity can be seen in the internal industrial structure of the more advanced countries, where by 1940 production of essential consumer goods accounted for over 60% of gross product, but only 45% in 1960. Meanwhile, from a bare 20 to 25% chemicals and metals accounted for 40% in 1960, the greater share going to the heavy industries in this field. By 1960 the structure of production was approximately as follows: consumer goods 50%, unfinished goods 40% (barely half of which were metals and chemicals), capital goods 10%.

4. To understand the nature of these changes in the pattern of industrial production, one must analyse and compare the changes that have been taking place in the pattern of imports. In relative terms, over the last 20 years, Latin American imports of consumer goods fell on average from 50% to 20%, whereas imports of unfinished materials rose from 20% to 40%, capital goods from 20% to 30% and fuels remained steady at 10%.

5. Four characteristic situations may be reached in countries in process of industrialisation: (a) a relatively balanced development of industry, cattle-raising and agriculture (possibly at low and medium levels, helping 'backward linkage' or following an independent course); (b) industrial growth at the expense of agriculture; (c) excessive growth of consumer goods production accompanied by a disproportionate rise in imports of semi-finished and capital goods; and (d) growth of basic capital industries balancing and harmonizing to some extent with growth in the consumer goods sector.

6. Typically, four main stages may be distinguished: (a) 'backward linkage' or original impetus, (b) 'forward linkage' with rising industrial demand, (c) radial expansion through growth of auxiliary industries, and (d) heavy industry. The first stage is the production of easily substituted consumer goods, but its advantages soon disappear because of the relative smallness of domestic markets even in those countries with the highest national income.

7. From the foregoing analysis some important conclusions emerge: (a) Industrialisation begins with intensive substitution of home-made light goods for foreign imports and a consequent increase in imports of essential materials and plant required for their manufacture.

(b) Recent industrial expansion is not the end of 'backward linkage', but stimulates a demand for additional imports.

(c) Immaturity of the industrial structure leads to considerable vulnerability as regards critical supplies.

(d) Consequently, heavy industry is the critical sector, whether as regards integration of consumer goods production or more highly specialized production and capitalization.

(e) Heavy industry (in countries where it has attained a certain level, but where there is an adverse trade balance) at once solves the problem of

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E/CONF.39/D/134
25 Oct.1962
ORIGINAL : ENGLISH

UNITED NATIONS CONFERENCE
ON THE APPLICATION OF SCIENCE AND TECHNOLOGY
FOR THE BENEFIT OF THE LESS DEVELOPED AREAS

Agenda Item: D.4.1

India

FOOD PRESERVATION AS A MEANS TO CONSERVING SURPLUS AGRICULTURAL AND FISHERIES PRODUCTION FOR DISTRIBUTION AND CONSUMPTION

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No. 475
D.4.1.

FOOD PRESERVATION AS A MEANS TO CONSERVING SURPLUS AGRICULTURAL AND FISHERIES PRODUCTION FOR DISTRIBUTION AND CONSUMPTION

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A significant feature of development in India in recent times has been the wide-spread application of science and technology in the field of food and agriculture. The application is being promoted and extended at all the stages from production through preservation to utilisation. Emphasis is being placed on achieving increased diversification in the food production with simultaneous development, not only of cereals, but also, of legumes, fruits and vegetables, milk, fish and other items needed for a balanced diet. A systematic approach is being made to conserve what is produced by a judicious combination of traditional methods and modern techniques. The different methods of preservation such as preservation by means of drying, fermentation and pickling, sugar, salt, chemical additives, refrigeration and freezing and canning are all encouraged. Preservation with ionizing radiation is only in an experimental stage. In addition, technological aids are also being sought in salvaging for human consumption food from certain potential resources which have not been hitherto adequately utilized. The discussion below will be restricted to a few aspects which will tend to illustrate how the problem is being tackled in India.

FOOD PRESERVATION AS A MEANS TO CONSERVING AVAILABLE FOOD SUPPLIES - INDIAN SITUATION.

The role of food preservation is not readily understood in most of the underdeveloped countries. Even some of the essential measures are often regarded as adding on to the cost of the fresh food and as avoidable. While this type of outlook is gradually

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changing, a large amount of educative work is still needed. A vast majority of people in some of the underdeveloped countries have to subsist on poor and inadequate diet while at the same time enormous quantities of food material rich in valuable protective constituents are allowed to be wasted or misused. It is the function of food technology to conserve this and make it available to all sections of the people. Foodstuffs are highly perishable and seasonal. There is often a surplus in the season of plenty particularly in the areas of production. Due to seasonal abundance and various bottlenecks in handling and transportation and other causes the foodstuffs are not all consumed immediately after they are produced but suffer deterioration to different extent. They are subjected to various kinds of damages such as depredation by rodents, insects and pests and microorganisms. If highly perishable items such as meat are not consumed quickly, they get putrefied. An interesting story is told as regards how in Europe spices came into use for disguising the unpleasant flavour of stale meat[1]. The spoilage of food in the hot and humid areas of the tropical countries is characteristically high. Therefore, it is not merely enough to produce the needed quantity of food but it must be properly taken care of until consumed. This is also interlinked with the question of providing an efficient and speedy transport system. Modern civilisation has very often to rely on foods produced in distant areas. Food transport and food preservation are closely linked and in many instances one would be impossible without the other[1]. Moreover, a well-developed food industry concerned with food preservation and processing would provide a steady market for various foodstuffs, facilitate storage and transportation, enable full advantage to be taken of seasonal abundance and help to fill the gaps in the supplies of various kinds of foods in areas and in seasons in which there is a shortage. Food preservation is thus an essential link between food production and consumption.

India's food supplies are at present inadequate to meet fully the needs of an optimum diet for the existing population. At the same time, the population, which is already high being 441.80 millions (in 1961), is increasing at a rapid rate of over 2% every year. Protective foods rich in proteins, vitamins, minerals, and other essential food factors are particularly in short supply. The dietary habits of the people are such that the bulk of the calories is derived from foodgrains. Fruits, vegetables, milk, meat, fish, eggs and other protective foods form only a very small proportion in the average Indian dietary. The per capita income[2] is very low being of the order of Rs. 330 per annum (in 1960-61). Over 80% of the people live in villages and follow traditional habits and customs. The literacy[3] is also low being 23.7% (in 1961). The per capita availability of cultivable land is so low and the socio-economic conditions obtaining in the country are such that even though there is potentiality for increasing the production, it will be difficult to keep pace with the growing pressure of population on land. Therefore, apart from other measures that are taken to meet the situation, there is urgency in promoting conservation of the available foodresources. The food so saved will itself contribute to a substantial increase in availability and improvement in nutrition.

THE FOODS TO BE PRESERVED.

The position regarding raw materials that have to be preserved and properly utilised is indicated briefly in Table 1. Even though the per capita availability of the food items is generally inadequate, India has large supplies of raw materials that have to be handled, suitably treated and distributed. India is one of the countries having a large livestock population (Table 2). It has large, though still insufficient, resources of oilseeds. A wide selection of fruits and vegetables many of which are indigenous to the country is also available. The indigenous resources of packing materials are also considerable. The country has, therefore, the potentiality for developing a flourishing food preservation and processing industry. But in view of the peculiar socio-economic situation obtaining in India the treatment given to natural foods should be the minimum that is essential. While expensive modern techniques may have to be applied for items meant for export, reliance will have to be placed largely on traditional methods and other simple techniques for meeting the local needs.

TRADITIONAL METHODS OF FOOD PRESERVATION.

There are several traditional methods of food preservation and processing in vogue in India. Some of the traditional processes have been put on scientific basis but there are several others the scientific rationale of which has not been fully worked out.

Pickle[4] constitutes an important section among the indigenous fruit and vegetable products. Mango, lime, amla, chilli, tomato, carrot, turnip, cauliflower, etc. are among the popular materials used for pickling. Both sun-dried and fresh fruits and vegetables are used. They are of two important types, namely oil-pickles and vinegar-pickles. The edible oils that are commonly used in oil-pickles are mustard, groundnut and sesame. The pickles are generally packed in earthenwares, glass jars, mud vessels and wooden barrels.

Chutney[4] is another product prepared from fruit and vegetables by cooking in sugar syrup with salt, spices and vinegar to a thick consistency. Mango is one of the most important fruits used for chutney.

The Indian preserves and murabbas[4] are made from certain fruits and vegetables by applying the principle of high sugar concentration for preservation. Amla, apple, ginger, petha, pear, carrot, pine apple, etc. are among the important preserves. The indigenous system of medicine, specially the Unani system, claims several medicinal properties for the Indian preserves.

Sun drying[5] has been one of the common methods of preservation practised in India for centuries. Highly perishable fruits and vegetables, roots and tubers, fish and several other products have been preserved in this manner. Mango, bitter gourd, okra, tomato

jack fruit, bread fruit, beans, sweet potato, potato and tapioca are some of the commonly known dried products. There has been a revival of interest in this technique in recent years and some commercial units have sprung up. Dried ripe banana is one such commercial product.

A class of indigenous paste goods, known as papads, is widely known. The raw materials used are Bengal gram, green gram, rice or potato flours. The papads can be baked on hot cinders or deep fried. A variety of other paste goods and macaroni like products are also in use. Sun drying is adopted in all these instances.

Sweet-meat or the Indian indigenous confectionery industry is largely functioning in the unorganised sector. A very large variety of sweets are known. Some of the main ingredients used are Bengal gram flour, wheat flour, rice flour, milk and milk products, shredded coconut, oil, ghee (clarified butter), sugar, nuts and oilseeds. The two most familiar varieties of sweets are 'Rasagola' - a product made from milk and 'Halwa' a product that uses wheat flour.

Parboiling of rice is a technique that is believed to have originated in India. It has been shown that parboiling of paddy (rough rice) would be of great value for obtaining greater yield during milling and for conserving nutrients. The traditional methods have been greatly improved in India by researches undertaken at the Central Food Technological Research Institute, Mysore (CFTRI) and the Jadavpur University at Calcutta, whereby the processing time has been reduced considerably to yield an improved product richer in nutrients, better in storage properties, and more agreeable in appearance and flavour. It has been estimated that if all the rice produced in India is parboiled, about half a million tons more of head rice would be available for consumption[5]. The improved techniques are being popularised and extended for achieving the desired objectives.

Some of the traditional methods of processing could be improved and made use of for achieving food preservation on a large scale.

FRUIT AND VEGETABLE PRESERVATION.

India produces a great variety of fruits, squashes, jams, pickles, murabbas, chutneys, etc. for home consumption as well as for export. Pine apples, mangoes, guavas, oranges, pears, litchis, peaches and papayas are some of the important types of fruits canned. Among the vegetables, the items commonly canned are cauliflower, cabbage, spinach, peas, okra, bitter gourd, French bean, tomato and curried vegetable. It is expected that the present annual production of about 40,000 tonnes of processed fruits and vegetables would increase to one hundred thousand tonnes by 1966. The quality of the products is controlled by the Fruit Products Order, 1955 administered by the Ministry of Food & Agriculture, Government of India, which prescribes minimum standards of quality and hygienic conditions. A close check on the quality of the products is maintained through technically qualified officials of the Government. Approximately 90% of the

production is carried out by small scale units. The industry has an organised sector which is developing rapidly on modern lines. There are a variety of typical Indian products that have attained a high reputation in international markets. The industry has already established an export market in spite of the high cost of production. Potentialities of accelerated freeze-drying technique are also being explored.

An intense campaign is being organised with short-term courses, demonstrations, fairs, exhibitions, etc. for the promotion of home scale food preservation.

Techniques are being developed to extend storage life of fruits and vegetables at ordinary temperature through control of respiration, enzymatic degradation and microbial attack while, at the same time, retaining all the desirable features of the fresh material. The CFTRI has found that the high melting component (melting point of over 75°C) of sugarcane wax is very useful as an emulsion for the purpose. The emulsion can also serve as a carrier for safe fungicides and growth regulators. Wax emulsion formulations have been evolved and conditions of treatment standardised for several fruits and vegetables. Measures are being taken for extending the application of the technique on a large scale.

PROTEIN TECHNOLOGY.

An approach that is being developed in India concerns the salvaging for human consumption of vegetable proteins from hitherto inadequately used resources such as oilseed-meals. Oilseeds, such as groundnut, sesame, mustard and coconut are processed in India primarily for vegetable oils. But the residual cakes resulting as a by-product of the vegetable oil industry is rich in protein, containing as high as 50% by weight of protein. As a result of studies undertaken over a period of years, the CFTRI has standardised the production and use of edible quality meals from peanut which is one of the most important oilseeds of India. The Government of India have already taken a lead in setting up with UNICEF assistance two units of capacity of 3,000 tons each per annum for the production of edible groundnut flour. The units are under erection and are expected to go into production shortly. The groundnut flour could be used in the preparation of a variety of foodstuffs such as protein-rich wheat flour, protein-rich biscuits etc. The CFTRI has also developed a high protein supplementary food from groundnut flour, incorporating with it a certain percentage of chick-pea meal and some amount of essential minerals and vitamins. These low-cost food preparations have been shown to be effective in overcoming protein mal-nutrition in India.

The CFTRI has also successfully evolved methods for the preparation of protein isolates by the direct processing of oilseeds to yield a high grade oil, together with quantitative yield of protein and other components without the use of solvents. Using such a protein from peanuts with about 95% purity, several formulations have been evolved with and without the addition of a certain percentage of

milk powder and with added dextrimaltose vitamins and minerals which can be utilised in the same way as milk. A more recent development in the line is the conserving of coconut proteins.

The CFTRI has taken up a programme of further work on exploring protein resources with the assistance from the National Institute of Health, USA.

Successful utilisation of buffalo milk in the production of infant foods has been facilitated by the work of the CFTRI[7]. The buffalo milk protein shows less stability during concentration and drying than cow's milk. This difficulty has been overcome by suitable addition of buffers such as are already present in milk. The process has been utilised by one of the large-scale milk processing units in India for production of infant foods based on buffalo milk.

There are various programmes for conserving milk[2].

Meat Technology is in its early stages of systematic development.

FISH PRESERVATION.

The annual catch of fish in India is of the order of 1.4 million tonnes of which about two-thirds comes from the sea and the rest from inland resources.

Efforts have been made during recent years to increase the facility for catching, storage, transportation and processing of fish. Mechanically operated vessels have been introduced in many important places to reduce the time lag between catching and landing. The use of ice for cooling the fish is being adopted in many places. A number of ice factories and cold storages have been established at important centres. Insulated road vans and carrier launches have been introduced recently at several centres. Some improvements have also been effected in packing of fish and fish products, with the object of minimising spoilage and wastage. Low cost containers have been developed which protect fish from physical injury during transport and handling and which at the same time act as heat insulators.

The chief methods of preservation practised in the country are (1) Sun-drying; (2) Salting and sun-drying; (3) Wet-salting; (4) Pit curing; and (5) 'Colombo' curing. Fish canning is carried out only on a small scale. The main obstacles in the way of development have been irregular supply of fish, lack of good and cheap containers and short duration of the canning season. Because of high cost of processed product, the canned fish is not within the reach of the average Indian. A method has been worked out at the CFTRI for the production of edible fish flour from oil sardine.[8] A nutritious product containing about 15% to 20% protein has also been developed from a blend of equal quantities of fish flesh and a starchy material like tapioca.

The CFTRI and the Fishery Research Laboratories maintained by the Central and State Governments are engaged in a series of researches designed to improve the techniques of production, preservation, packaging and transportation of fish. The production of fish is expected to increase to 1.8 million tonnes by 1966. Fish is already a valuable export item in India.

IMPROVED PACKAGING, TRANSPORT AND STORAGE OF PERISHABLES.

The bulk of the highly perishable foods in India is produced at locations away from large centres of consumption. The production centres are not easily accessible by roads or rail. Some of the articles have to be transported hundreds of miles before they can fetch a reasonable price. Facilities for transport such as ventilated wagons for fruits and vegetables and refrigerated wagons for fruits, fish and other items are inadequate. Transport of perishables by air is rare, but there is a lot of scope in this direction. The products are carried usually as headloads by primary producers or in animal-driven carts and less frequently in lorries and trucks to the nearest collection centres. The products are largely disposed of at these centres. Small amounts are transported by organised trade to larger metropolitan centres in carts, trucks or trains. Jute bags, bamboo and wicker baskets and wooden crates of different shapes and sizes are largely used for packing perishable commodities. Mud pots, palmyra mats and other improvised packages are also used for a variety of purposes. The dimensional stability and ability to withstand stacking need to be improved so that they could be made strong enough to withstand rough handling. Cushioning materials used include husk, straw, saw-dust and the like. Use of refrigerated transport is available only to a very negligible extent and is mostly confined to fish and milk. Packages in India are not generally standardised. Defence Services, however, accept articles only when packed in standard packages for which specifications are available. The newly formed Division of Packaging at the CFTRI[8] is studying a number of local problems, the solution of which is designed to save considerable amount of perishables which is at present damaged. Efforts are being directed towards (i) increasing the production of packaging materials; (ii) improving the existing packages; (iii) developing new packaging materials from locally available raw materials suitable to the different kinds of foodstuffs and to the different conditions of transportation and handling; (iv) standardising packages; (v) pre-treating of perishable foods; (vi) pre-packaging of perishables; and (vii) developing proper packages for goods intended for export.

COLD STORAGE AND REFRIGERATION.

India does not have adequate cold storage and refrigeration facilities. There are at present over 200 cold stores in the country with an average capacity of 670 tonnes. Most of the cold stores situated in inland towns have been storing mainly potatoes but cold stores in port towns like Bombay, Calcutta and Madras are basically multipurpose, where a wide range of commodities like fish, meat, liver, apples, etc. are stored. Optimum conditions of refrigerated

preservation of a variety of Indian fruits and vegetables have been worked out[8]. Some data have also been collected on the frozen storage of fruit products. The chief difficulty standing in the way of expansion of cold storage of perishable foods in India is the lack of adequate equipment, some components of which have to be imported.

DEVELOPMENT AND EXTENSION.

There is at present a wide gap existing between theory and its practical application in the field of food preservation and nutrition. This is partly so because the task of getting popular acceptance for a new technique or a new product in India is tremendous. To fill up this gap, a Food Extension Service is being established by the Government of India which will inter alia undertake a systematic and intense campaign with the aid of a fleet of properly equipped and staffed mobile vans for the application of food preservation, prevention of wastage, promotion of diversification of the dietary habits, popularisation of low-cost balanced diets and spreading knowledge concerning scientific techniques of cookery and utilisation of food. These units will keep liaison with the various training centres, research organisations, teaching institutions and other agencies concerned with food and would function as the focal points for the dissemination of the scientific information on food.[9] There is a special technical division dealing with such and allied matters in the Ministry of Food and Agriculture. This division initiates programmes for suitable application of the results of research and other developments in the field of Food and Nutrition, with the advice of "the Scientific Food Advisory Panel" constituted by the Government of India.[5]

CONCLUSION.

A systematic approach is thus being made for the judicious application of science and technology for achieving efficiency in food conservation. Some of the measures are designed to promote the traditional methods of preservation. Some are concerned with adapting modern techniques to suit local conditions. Others are largely new and experimental lines developed in India.

TABLE - 1*

Production of Foods in India (Thousand metric tonnes/year)

FOODS		1951-52	1960-61
1. Cereal			
Rice		21,729	34,241
Wheat		6,270	10,819
Others		17,005	22,817
	Total:	45,004	67,877
2. Pulses			
Gram		3,441	6,307
Others		5,102	6,360
	Total:	8,543	12,667
3. Roots & Tubers			
Potatoes		1,712	2,699
Cassava		1,262	1,781
Sweet Potato		1,203	1,281
	Total:	4,177	5,761
4. Sugar		6,163	8,829
5. Nuts & Seeds			
Groundnut		3,192	4,424
Sesamum		452	293
Coconut		2,019	2,722
Rapeseed		943	1,402
Linseed,		333	417
	Total:	6,939	9,258
6. Fish		700	1,422

TABLE - 2*

Livestock population in India (thousands)

	1951	1961
Total Cattle	155,295	175,672
" Buffaloes	43,400	51,137
" Goats	47,155	60,813
" Sheep	39,052	40,263
" Pigs	4,486	Not available
" Poultry	75,548	116,914

*Source: - Directorate of Economics & Statistics, Ministry of Food & Agriculture, New Delhi.

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1316 E - Oct.1962 - 1,600

E/CONF.39/D/134 SUMMARY

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E/CONF.39/D/134
SUMMARY
25 Oct.1962
ORIGINAL : ENGLISH

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SUMMARY

Agenda Item: D.4.1

India

FOOD PRESERVATION AS A MEANS TO CONSERVING SURPLUS AGRICULTURAL AND FISHERIES PRODUCTION FOR DISTRIBUTION AND CONSUMPTION

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S U M M A R Y

In underdeveloped countries, a large section of the population subsists on deficient and inadequate diet, while considerable food material rich in nutrients is wasted and spoilt. A well-developed food preservation industry will salvage this loss for human consumption, facilitate storage and transportation and even out the seasonal glut to make it available in areas and seasons of shortage. The food so saved will itself contribute to a substantial increase in availability. Food preservation is thus an essential link between production and consumption. The treatment given to natural foodstuffs in India has to be the minimum necessary to facilitate handling, transportation and preservation as it is conditioned by the low per capita income, the influence of traditions and habits and other socio-economic factors. Traditional methods, such as sun-drying, parboiling, pickling, preserves making etc. have, therefore, an important role to play.

The Fruit and Vegetable Preservation Industry is developing rapidly in India to meet the internal and export demands. The quality of the products is controlled under the Fruits Products Order 1955, administered by the Government of India. Wax emulsion formulations based on sugarcane wax and conditions of treatment have been standardised for extending the storage life of fruits and vegetables at ordinary temperature.

Efforts are being made for salvaging for human consumption vegetable proteins from resources such as oilseed-meals. Two units with a capacity of 5,000 tons each per annum are being established for the production of edible groundnut flour by the Government of India in collaboration with the UNICEF and private enterprise. Protein-isolates have also been recently developed from peanuts. The work is being extended to other vegetable protein resources. A process has been developed for the preparation of buffalo-milk powder for use in infant foods.

Fish preservation is being developed as an important industry for meeting internal as well as export needs. Emphasis is being placed on improved techniques of production, handling and preservation. Extensive researches are being sponsored by the Government for the rapid development and modernisation of the industry. Research work is in progress for developing suitable packages for the different kinds of foodstuffs to withstand the varying conditions of transportation and handling.

A Food Extension Service is being established by the Government of India for undertaking a systematic campaign, with the aid of a fleet of mobile vans, for the application of food preservation, promotion of diversification of the dietary habits, popularisation of low-cost balanced diets, dissemination of scientific information on food and collection of food consumption data. The service is designed to bridge the gap existing between theory and its practical application in the field of food preservation.

A systematic approach is thus being made for the judicious application of science and technology for the promotion of diversification in production, effective utilisation and efficiency in preservation. Some of the measures are designed to improve and promote the traditional methods of preservation. Some are concerned with adapting modern techniques to suit local conditions. Other are largely new and experimental lines developed in India.

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E/CONF.39/D/135
25 Oct.1962
ORIGINAL : ENGLISH

UNITED NATIONS CONFERENCE
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Agenda Item : D.13

Australia

DEVELOPING THE STRUCTURAL USE OF NATIVE TIMBERS : IMPORTANT TECHNOLOGICAL FACTORS

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No. 1026
D.13.

DEVELOPING THE STRUCTURAL USE OF NATIVE TIMBERS

IMPORTANT TECHNOLOGICAL FACTORS

by

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INTRODUCTION

1. Factors influencing the structural use of timbers include average intrinsic strength, variability of the clear material, grade, difficulties of working, shrinkage, and others affecting jointing etc. Before the specific value of a particular species can be assessed or the relative values of a number of species determined, extensive investigations, planned to what is practicable, should be undertaken. There is a natural tendency, particularly for countries comparatively inexperienced in timber technology, to follow overseas standard procedures and specifications without question although they may not be particularly well suited to their needs. However, there is little doubt that a discussion of its special problems between an inexperienced country and more experienced countries may lead to quicker, cheaper and more satisfactory solutions.

SAMPLING PROCEDURES

2. The standard procedure, as outlined by the American Society for Testing Materials,[1] is to obtain a few logs of the species to be studied, then cut a very large number of specimens from them according to a defined pattern, and test them. In advance of final calculations, it will not be at all clear whether the result will give the properties to a precision greater or less than the minimum which is economically appropriate. If a large number of species must be tested, obviously each need be tested only to the minimum extent indicated by its value. So by a controlled total effort a greater number of species may be studied in a given time.

3. If strength properties are unknown for a large number of species, a quick approximate assessment may first be made of the potential of each, thus, for controlled development of the use of local timbers obtaining the strength properties to a precision within say ± 15% of the species mean may be a satisfactory first step. This may be done with a very small sample. In the laboratory, useful strength data may thus be obtained on as many as 30 or 40 species in the time that would be required for only one species by the old standard method. More intensive tests can then be done on specially selected species to increase the precision of estimate of the important strength properties

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[1] American Society for Testing Materials, Standard methods of testing small clear specimens of timber, A.S.T.M. Stand. D143-52 (1952).

progressively to ± 10% or ± 5%, in perhaps as little as one-tenth the testing time required with conventional species testing.

4. To achieve a particular precision the size of sample can be approximately determined in advance. From tests on a large number of Australian species it appears that if five trees are properly selected, and only one specimen for each type of test is taken from each tree, the mean values will determine the species mean properties to ± 15%, if the sample be eight or ten trees, then to ± 10%, if 24 then to ± 5%. A more precise estimate of the increase in size of sample necessary to improve the precision by a selected amount may be obtained by an analysis of the data of the first sample, and by application of the principles proposed by Pearson.[2]

5. All samples must be properly representative of the population of trees of most interest to the wood technologists and, ultimately, the timber users. The best methods of sampling are referred to by Pearson[3] and by Pearson and Williams.[3] Even where it is known in advance that a high order of the precision of the estimate of the species mean is required for particular species, the system of sampling, whereby only one specimen of each type is selected from each tree, is much less expensive than the older standard method.

STRENGTH GROUPING OF TIMBERS

6. In Australia it is found economically desirable to utilize a very wide range of timber species. Under the Australian system relatively limited technical data are sufficient to allow a fairly efficient strength grouping. Once the timber is strength grouped, there is a simple and ready basis for indicating satisfactory and not too conservative working stresses.

7. Strength groups having been established, one simple test such as density may be sufficient as a preliminary basis of strength grouping a new timber. Alternatively, a limited number of strength tests, such as bending or compression, will provide greater assurance of proper grouping and thus definition of working stresses, including those for other strength properties, with adequate degree of accuracy. Essentially, strength grouping is based on data from carefully standardized tests made on defect-free samples representative of each species. Strength-reducing defects are separately allowed for by systems of strength grading, referred to later.

8. To initiate strength grouping the mean strength properties of the weakest and the strongest timbers of all species to be included are estimated. The probable extreme range of strength of the economic structural species should then be divided into several strength groups, choice of their number being determined by use of the potential strength of each species to the maximum consistent with not excessive costs in separating, storing and selling.

9. Technically, instead of using the mean strength properties of a species, a more efficient grouping may be based on the weakest possible

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[2] Pearson, R.G., The sampling of timber for standard mechanical tests. Aust. J. Appl. Sci., 3, 25-52 (1952).
[3] Pearson, R.G., and Williams, E.J., A review of methods for the sampling of timber, For. Prod. J. 8, 263-268 (1958).

piece in the species.[4] However, a system based on the lower probability limit stress, such as the 99% lower limit value, is practicable only after the properties of a considerable number of species are known precisely enough.

10. Usually the more important strength properties are given precedence in grouping, particularly modulus of rupture, maximum crushing strength, modulus of elasticity and shear strength. According to the marketing conditions, the strength grouping may be in 2, 3 or more classifications. In Australia the groups are A,B,C and D. Most of the hardwoods fall in the first three, local and exotic softwoods in the fourth. It so happens that density is a fairly good index of these strength properties, being closely correlated with maximum crushing strength. Thus, the densest timbers tend into A, the lightest into D.

11. Frequently, in Australia, species are difficult to separate by appearance of the sawn timber. However such species from one particular growth zone tends generally to be of the same strength group as others from it.

12. Structural design with strength grouped timbers is founded on the use of working stresses independent of species in the group. To do this safely working stresses should be determined on the basis of the weakest member of the group. As technical information about particular species increases any species becoming important enough to justify separate marketing and separate working stresses can be easily dealt with independently of the grouping system.

13. The general structure of the strength groups is apparent in the modulus of rupture range (Table 1). Similar ranges are developed for the other important structural properties. Of course some timbers will not exactly fit into ranges for all properties in a strength group, because the ratios of the various strength properties differ somewhat between species. However it is usually not difficult to group them according to the most important properties.. Average basic density values for timbers in the Australian strength groups tend to follow closely the strength properties.

GRADING OF STRUCTURAL TIMBERS

14. Much of the grading of sawn structural timber throughout the world is based on studies made in U.S.A. of the effect of knots and other defects on the strength of Douglas fir. Because of cost confirmatory tests are not usually made on other species. There is now some evidence that the effects on strength of similar blemishes in hardwoods are not always the same as in softwoods. Further, the application of grading rules based on Douglas fir studies to fast-grown species of either softwoods or hardwoods may also be misleading. Rules for the grading of the species of one country may sometimes not be even reasonably efficient for the species of another.

15. Also it is not valid to deduce that the rules are safe just because structures apparently have not failed when built with timber graded to the rules. Various factors apart from grading, are concerned in the derivation of working stresses and in the structure one may compensate another. Also there is the possibility that the maximum

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[4] Pearson, R.G., Variability of timber and the derivation of design stresses, Aust. J. Appl. Sci., 3, 144-155 (1952).

TABLE 1

AUSTRALIAN TIMBER STRENGTH GROUPS

Strength Group	Modulus of Rupture lb/sq in		Density lb/cu ft	
	Green	12% Moisture Content	Green	12% Moisture Content
A	15,000	24,000	75	66
B	12,000	20,000	65	59
C	10,000	16,000	60	50
D	7,000	12,000	45	35

loads for which the structures are designed have not actually been applied. Thus, even if the allowance made for defects during grading were seriously incorrect, substantial failures may not have occurred. Even should the structure prove faulty later, it is unlikely there would then be a clear indication that improper grading was the cause.

16. Despite these difficulties, structural utilization of timber unquestionably requires establishment of reliable timber grading. However technologists should not base rules on those of another country without first finding out whether the latter have been adequately tested in practice. Moreover they must also give heed to the quantity and the quality of the trained labour available in their own country to use and administer the rules and have regard to business practice there.

17. Selected grade levels may be proportions of clear material strength which depend on the class of logs available, the proneness of the species to serious defects, and the marketing conditions. Examples are 50, 60 and 75 per cent. grades, each of which is intended to contain no piece of a strength less than the stated percentage of the strength of defect-free timber. In the early stages of selling timber of graded strength, it is unwise to complicate marketing by having more than the minimum practicable number of strength grades.

FACTORS AFFECTING THE STRUCTURAL UTILIZATION OF NATIVE TIMBERS, PARTICULARLY HARDWOODS

Density and Its Effect on Seasoning

18. Most hardwoods are considerably denser than the softwoods traditionally used for building in Europe and North America. These dense timbers dry very slowly. As a consequence, economic considerations generally lead to their use green or fairly green in construction. Nevertheless, for some uses, for example, flooring and trimming, these timbers are seasoned.

Growth Stresses

19. In hardwoods, growth stresses tend to be considerably higher than in softwoods. Growth stresses also cause splitting of logs, but the resulting loss may be reduced if the natural drying from the end of

the log is restricted by the use of a suitable coating material and the storage of logs in the shade, under water sprays or under water. Growth stresses can be particularly important and helpful in the case of timbers used in the round condition, i.e. poles and piles. However in sawn timber, they may have a serious degrading effect on strength, particularly on the timber near the centres of large trees. This "brittle heart" material is very low in impact strength, and its use structurally may lead to serious consequences. However, it is possible to separate it from the sound timber because of its different sawing characteristics, and its brittleness as shown by a knife test.

Hardness and Splitting Tendencies

21. The high density of hardwoods is indicative of increased hardness, Generally nails should be of heavier gauge than for softwoods or be hardened or of high strength.

Shrinkage Tendencies

22. Where hardwoods are used green for the framing of structures, provision must be made for subsequent shrinkage. Structural design and appropriate technique should ensure shrinkage does not cause weaknesses, instability or unsightliness of the building. Restraint to shrinkage movement across the grain may result in splitting. Special attention should therefore be given to the design of joints in green hardwood and care used in their fastening.

Creep

23. The deflections of beams under long-duration loading may increase to several times the values for short-duration loading. Due allowance for this must be made in structural timber design.

There is considerable experimental evidence that members of Australian hardwoods allowed to dry out under structural loads deflect appreciably more than those kept at constant moisture content. Their slow drying and high shrinkage require consideration of this effect. Particular attention should be given to columns as for them the amount of deflection determines the stress.

EXPERIMENTAL PROCEDURES AND RECORDS

24. Many countries are severely handicapped in obtaining the technological data necessary to exploit properly their native timbers. Suitably trained personnel are few, and testing facilities and equipment are generally limited. Yet the most expeditious assembly of necessary data is desirable, the highest efficiency necessary.

25. Testing methods have been debated by outstanding experts in world conferences. The resulting endorsed test methods, such as those published by F.A.O., should be carefully followed; so too should the most efficient sampling methods. It is very important that all testing conditions be recorded and published with the test data and that the botanical identity of all timber tested be established.

26. The determination of basic density, i.e. the oven-dry weight of a sample of timber, divided by its green volume, is recommended as the best density property for comparison of hardwood species. This avoids difficulties arising from differing shrinkage and collapse tendencies in different species.

27. Use of statistical methods in the processing of data is highly recommended, and measures of variability of that data, such as the standard deviation of individual results and the standard errors of species mean values, should be published. Only in this way can the value of the data be thoroughly assessed.

28. Every effort should be made to achieve the greatest practicable co-ordination of the technological studies of the different countries and it is highly desirable that a central technical information bureau be established for the purpose.

1371 E - Nov. 1962 - 1,600

E/CONF.39/D/135
SUMMARY
25 Oct.1962
ORIGINAL : ENGLISH

UNITED NATIONS CONFERENCE
ON THE APPLICATION OF SCIENCE AND TECHNOLOGY
FOR THE BENEFIT OF THE LESS DEVELOPED AREAS

SUMMARY

Agenda Item : D.13

Australia

DEVELOPING THE STRUCTURAL USE OF NATIVE TIMBERS : IMPORTANT TECHNOLOGICAL FACTORS

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Papers have been contributed to the United Nations Conference on the Application of Science and Technology for the Benefit of the Less Developed Areas as working papers for that Conference. They are published as presented by the contributors, and the contents and the views expressed are those of the contributors. (See notes overleaf.)

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DEVELOPING THE STRUCTURAL USE OF NATIVE TIMBERS

IMPORTANT TECHNOLOGICAL FACTORS

by

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Sampling is of prime importance in the assessment of timbers for structural use. Methods recommended by some standard timber specifications, for instance, the taking of a large number of test specimens from a relatively small number of trees, are regarded as inefficient and uneconomical.

A quicker and more efficient approach is to take only one specimen of each type from each tree, and sample trees of a species on a step by step basis. For a quick assessment of each species it is often adequate to sample a few trees to obtain the strength properties to a precision of ± 15% of the species mean. If the species appears promising the sample can be increased to give a precision of ± 10%, and even ± 5% if the timber is likely to be of high economic importance.

It is essential that, at each step, the sampling should be properly representative of the population of trees of most interest to the wood technologists and, ultimately, to the timber users. Such a method has been found to increase up to 10-fold compared with other methods the rate of obtaining precise information on strength properties.

Where it is economically desirable to utilize a very wide range of timber species, as in Australia, the practice of dividing the timbers into a few strength groups, each of which has its own set of basic working stresses, has several advantages. Less precise information is required to allot a species to a strength group than to enable reliable working stresses to be derived for that particular species. The basis of the allocation of a species to a strength group is provided in the paper.

Assessment of the effects of defects on the strength of wood is essential to the safe and efficient use of timber for structural purposes. It is important that a critical examination be made of grading rules already in use in other countries before adopting them.

In the utilization of native timbers, particularly hardwoods, there are several factors affecting their efficient use sometimes to a critical degree. The higher density of the hardwoods and the consequent slower rate of seasoning generally lead to these timbers being used structurally in the green condition. Growth stresses in the living tree are generally at a higher level in hardwoods than in softwoods. They cause the defect known as "brittle heart" in hardwoods

and also lead to end splitting and to distortion on sawing.

The greater shrinkage of hardwoods and the tendency of some to "collapse" during seasoning require that special care be taken in structural design, but experience in Australia and elsewhere has shown that the use of suitable techniques can overcome all of the serious problems that might arise.

Special allowance in design stresses has to be made for the effect of long-duration loading, including the increased deflection in beams and columns resulting from changes in moisture content as structural members erected in the green condition dry out in service.

In order that tests on timber species should have maximum value, not only in the originating country but also to other interested countries, it is very important that all conditions of test be recorded and published with the test data. It is also important to establish properly the botanical identity of all timber tested. It is recommended that statistical methods be used in processing test results and that measures of variability, such as the standard deviation of individual results and the standard error of the estimated species mean value, be published.

The suggestion is made that a bureau be established for the co-ordination of technological studies in different countries, the examination of test data and the dissemination of information.

S - 1371 E - Oct.1962 - 1,600

E/CONF.39/D/136
26 Oct.1962
ORIGINAL : ENGLISH

UNITED NATIONS CONFERENCE
ON THE APPLICATION OF SCIENCE AND TECHNOLOGY
FOR THE BENEFIT OF THE LESS DEVELOPED AREAS

Agenda Item: D.4.2

Australia

COMMERCIALLY FEASIBLE METHODS FOR THE DEHYDRATION OF MEAT

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Papers have been contributed to the United Nations Conference on the Application of Science and Technology for the Benefit of the Less Developed Areas as working papers for that Conference. They are published as presented by the contributors, and the contents and the views expressed are those of the contributors. (See notes overleaf.)

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COMMERCIALLY FEASIBLE METHODS FOR THE DEHYDRATION OF MEAT.

by A.R. Prater, Division of Food Preservation, Commonwealth Scientific and Industrial Research Organisation, Sydney, Australia.

1. From earliest times meat has been preserved by sun-dryers. Meats sun-dried are still an article of commerce in some regions, though of variable, usually low, quality, acceptable by reason of acquired taste. In most of the less developed countries diet is often seriously deficient in animal protein, because of insufficient livestock or the physical or economic difficulties of providing them with meat. The special advantages of dried meats in these and like circumstances are: they weigh less, occupy (particularly if compressed) less space, save expensive packing materials such as tin-plate, and store well without costly refrigeration.

2. Drying methods other than sun-drying are termed 'dehydration'. Giving better quality and greater supply, meat can now be dried commercially in various types of dehydrators by processes that are strictly controllable. This paper is mainly concerned with dehydration and its technology, with emphasis on methods commercially feasible in under-developed countries.

DEHYDRATED MEATS

3. These may be prepared in many forms such as powder, mince, slices, chunks, steaks, and chops. By careful handling and correct processing much of the form is retained. For example, with a dried mince, there should be only a very small quantity of fine material.

4. When the freshly prepared product is reconstituted and cooked it should have a full meat flavour and be free of off-flavour. Stale flavours may result from use of carcasses with microbial slime, from dirty equipment, and from deterioration of the product during storage; foreign flavours from tainted air or proximity to volatile odours. Other off-flavours may occur such as rancid (due to rancidity of the fat), burnt (from overheating during drying), and pressure-cooked (through pressure pre-cooking).

5. The use of carcasses of aged animals results, except in heated air drying of mince, in a product lacking in tenderness and juiciness. Pressure cooking of meat results in not only an undesirable flavour but a defect known as "woolliness" which may be likened to chewing a piece of cotton wool. Products from the emaciated carcasses are dry and lack the desired degree of fattiness.

6. The dried product should be capable of fairly rapid

reconstitution, and of taking up sufficient water to ensure it is not lacking in juiciness. The time taken for reconstitution is highly dependent on the form of the product and its method of production.

7. The nutritive value of the protein of the dried product should approximate that of the freshly cooked meat from which it is prepared. Sharp[1] has shown the nutritive value of air-dried mince, as measured by feeding studies on rats, to be very satisfactory, when the drying temperature was kept below 80°C. The biological value of the protein falls during storage of the product. Changes in the vitamin content must be considered also, particularly the vitamin B group. Losses of these during the preparation of air-dried mince were similar, in general, to those during ordinary household cooking.

8. To ensure a good quality product of satisfactory keeping quality strict hygiene, including scrupulous cleanliness of person, equipment and premises are necessary in all stages of processing and subsequent handling. High standards of slaughtering and meat inspection must be observed. To limit growth of micro-organisms delays between stages should be avoided. There should be as little as possible physical handling of meat, particularly after it has been sterilized by pre-cooking.

DRYING METHODS

9. Sun-Drying. Sun-dried meats reconstitute very slowly and their flavour and texture do not closely resemble those of freshly cooked meat. Sharp[1] has described the traditional methods still in use for preparation of charqui, biltong and pemmican.

Charqui, an important article of commerce in Central and South America, is made from strips of fatty beef which are brined prior to sun-drying on racks. Bilton differs from charqui by being a lean product; strips of legs or loins are lightly cured before drying in the shade in open sheds. Pemmican, originally prepared by the North American Indians, consists of sun-dried strips of lean meat pounded to a fine meal and mixed with rendered fat.

10. Drying processes other than sun-drying are termed dehydration. A wide variety of methods have, for purposes of this paper, been grouped into three classes. The form, quality and keeping properties of the dried product vary considerably with the different methods of processing:

(a) Heated Air. Only pre-cooked mince can be dried satisfactorily by heated air. Boneless pieces of meat are cooked lightly and the resultant liquors are concentrated and returned to the minced cooked meat before it is dried. Further details and references to relevant research papers may be found in a paper by Prater.[2] Types of air dryers which have been used for drying mince include cross-draught and through draught dryers, both batch and continuous, and the roto-louvre. More recently, a belt trough dryer has been developed, capable of drying many granular products in a shorter time than more conventional types. Its suitability for meat still requires testing.

(b) Drying Under Reduced Pressure: By vacuum methods raw and cooked

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[1] Sharp, J.G., Dehydrated Meat, Spec. Rep. Fd. Invest. Bd., Lond., No. 57 (1953).

[2] Prater, A.R., Meat Dehydration, C.S.I.R.O. Aust. Div. Food Pres. Circ. 6-P (1962).

and steaks may be dried, as well as mince, but they are more expensive and difficult to convert from a batch to a continuous process. Using vacuum drying, dried chunks and steaks of acceptable quality may be produced; but not when the meat comes from carcasses of aged animals Meat of this quality is satisfactory only as air-dried mince, which is tenderized by the mincing operation. In the New Zealand vacuum method, water is removed rapidly by dropping frozen chunks of meat into molten fat contained in a vacuum vessel. The fat is heated in an external heat exchanger and acts as the heat transfer medium. Initial quality is usually reasonable, but storage properties are poor. An additional disadvantage is that overnight soaking is required for reconstitution. At its present stage of development the freeze drying method could not be considered commercially feasible for less developed areas. However, as the quality of certain products is often exceptionally high, it is felt it should be mentioned. Water frozen in the raw material is subsequently removed by sublimation under high vacuum at low temperatures. Several techniques recently developed for speeding up the process aim at maintaining quality with economy of cost.

(c) Contact Drying: The melter dryer is basically a steam jacketed horizontal cylinder fitted with a paddle agitator. The product consists of very small particles having an unpalatable, bitter, burnt flavour and is of low biological value. By the application of a vacuum, and by keeping the temperature below 70°C, an improved product can be produced but even so it is not comparable with the air dried product. Roller drying depends on exposing a meat slurry for a short time to contact with the surfaces of steam heated rollers maintained at a high temperature. Improvement in quality may be obtained by application of a vacuum and lowering the drying temperature.

11. Provided that meat in the form of mince is acceptable to the people concerned, it is considered that air drying compares more than favourably with the other methods described.

PACKAGING AND STORAGE

12. Types of Deterioration are set out below:

(a) Microbial Growth: Dried meat will absorb moisture readily if exposed to the atmosphere for any length of time, thus making possible the growth of moulds and bacteria. To prevent this the dried meat must be packed in a moisture-proof rigid or flexible container.

(b) Changes in Fat Fraction: Two well known types of chemical change which may take place in the fat fraction of dried meat are hydrolysis, leading to liberation of free fatty acids, and oxidation, leading to the onset of rancidity. The former does not have a serious effect on flavour and the latter can be controlled by gas or vacuum packing or, if permitted, by the use of antioxidants.

(c) Changes in the Protein Fraction: Exclusion of oxygen by gas or vacuum packing retards the development of certain off-flavours in the protein fraction, but others, termed "browning changes", develop in gas-packed material. Browning changes, which can be retarded, are not usually of serious consequence unless a particularly long shelf life is required.

13. Packing Methods: Rigid containers such as those made of tin-plate give not only the best moisture and gas barriers but, by their rigidity, protect the contents against damage. Flexible types may be used providing they serve as a good barrier to gas and moisture. Nitrogen is recommended for commercial gas packing of dried meat. Compression of air dried mince results in the exclusion of most of the air so giving a shelf life to the product which almost equals that of gas-packed material.

13. Effect of Temperature on Shelf Life: The shelf life of dried meat depends on a number of factors such as quality of raw materials, type of process, type of pack, and temperature of storage. Increasing the temperature of storage reduces the shelf life. For example, dried mutton mince has a storage life of approximately 10 months at 77°F. and 1½ years at 32°F. Gas packing increases these figures to 2½ years and somewhat greater than 3 years.

1360 E - Nov.1962 - 1,600

E/CONF.39/D/136
SUMMARY
26 Oct.1962
ORIGINAL : ENGLISH

UNITED NATIONS CONFERENCE
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Australia

COMMERCIALLY FEASIBLE METHODS FOR THE DEHYDRATION OF MEAT

By A.R. PRATER,
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COMMERCIALLY FEASIBLE METHODS FOR THE DEHYDRATION OF MEAT.

by A.R. Prater, Division of Food Preservation, Commonwealth Scientific and Industrial Research Organisation, Sydney, Australia.

The diet of people in less well developed areas is often seriously deficient in animal protein. In some circumstances the most economical provision of the needed protein may be in the form of dried meat. Sun dried meat, which has been produced under primitive conditions from time immemorial, is acceptable in small communities by reason of convenience and acquired taste.

For more widespread consumption, meat is now dried in various types of dehydrators in which the processing conditions can be strictly controlled.

The main advantages of drying are the savings in weight and space, particularly if the product is compressed, and in packaging material. Long storage life without costly refrigeration is an additional advantage.

In an assessment of quality and keeping properties of dried meat many factors must be considered including: form (powder, mince, slices, chunks, steaks and chops), meat flavour and absence of off-flavours (stale, foreign, burnt, pressure-cooked, and rancid), texture (tenderness, juiciness, woolliness and fatness), reconstitution, nutritive value, and microbial contamination. It has been shown by J.G. Sharp ("Dehydrated Meat", Special Report of the Food Investigation Board, London, 1953) that the nutritive value of air dried mince is satisfactory, providing the drying temperature is kept below 80°C. In general, losses of the vitamin B group are similar to those found in household cooking.

A variety of commercially feasible methods for dehydration of meat is available and in selecting any one, the factors to be considered are: quality of raw material, the final form of the dried meat desired, its quality and shelf life, the effect of its processing on nutritive value, palatability, the economics of the process, and the availability of essential services.

The following methods are described and discussed:-

(a) Drying by heated air. Only pre-cooked mince can be dried satisfactorily by this method. After boning, pieces of meat are cooked lightly at atmospheric pressure and the concentrated cooking liquors are returned to the minced cooked meat before drying. Further details and references to relevant research papers may be found in a paper by A.R. Prater. ("Meat Dehydration", C.S.I.R.O. Division of Food Preservation, Circular 6-P, 1962), including cross-draught and through-draught (both batch and

continuous) and the rotolouvre. A possible new type is a belt trough dryer developed for other foods; this however has yet to be proved satisfactory for meat.

(b) Drying under reduced pressure. The use of this principle makes possible the drying of pieces of meat such as chunks, steaks, and chops. Three examples of techniques using this principle are: vacuum drying, New Zealand vacuum method, and freeze drying. Dried meat chunks of reasonable quality are produced by vacuum drying, but unlike air drying, tough meat from aged animals cannot be utilised satisfactorily. In the New Zealand method water is removed rapidly by dropping frozen chunks into heated fat in a vacuum vessel. Although the initial quality of the product may be reasonable its storage life is poor. Freeze drying, although capable of giving a high quality product, cannot at its present stage of development be regarded as commercially feasible in the less developed areas.

(c) Contact drying. Drying in a melter dryer, which is basically a steam jacketted horizontal cylinder with a paddle agitator, produces a rather unpalatable product of low nutritive value. Dried meat powder may be produced on roller dryers, but the danger of scorching is great. Some improvement in the quality of the products from both methods may be made by the use of a vacuum with a lower drying temperature.

Dried meat is perishable and, to maintain quality a careful control over packaging and storage conditions is necessary. To minimise water uptake, and so restrict mould and bacterial growth, dried meat must be packed in a moisture-proof rigid or flexible container. Oxidative charges leading to the development of stale flavours may be minimised by packing in nitrogen in gas-proof containers. Compression of the meat, which excludes a high proportion of the air, enhances shelf life. Lowering the temperature of storage increases keeping qualities. For example, air packs of dried mutton mince having a shelf life of approximately 10 months at 77°F, may maintain quality for 18 months at 32°F. Gas packing should at least treble these times.

Generally, it may be stated that if mince is a form of meat acceptable to the peoples of less developed areas, then the method of drying by heated air compares more than favourably with the other methods.

S - 1360 E - Nov.1962 - 1,600

E/CONF.39/D/13?
26 Oct.1962
ORIGINAL : ENGLISH

UNITED NATIONS CONFERENCE
ON THE APPLICATION OF SCIENCE AND TECHNOLOGY
FOR THE BENEFIT OF THE LESS DEVELOPED AREAS

Agenda Item: D.13

Australia

NEW VERTICAL KILN PROCESS FOR CEMENT MANUFACTURE

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Papers have been contributed to the United Nations Conference on the Application of Science and Technology for the Benefit of the Less Developed Areas as working papers for that Conference. They are published as presented by the contributors, and the contents and the views expressed are those of the contributors. (See notes overleaf.)

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NEW VERTICAL KILN PROCESS FOR CEMENT MANUFACTURE

by S. Gottlieb, Gippsland Cement Ltd., Melbourne, Australia.

1. In recent years, systematic studies in many parts of the world have been conducted with the objective of designing a kiln which would perform fully uniform sintering of cement clinker in a press-button controlled automated process. It has been known for many years that it is possible to automate high temperature processes fully only if they can be made independent of the need for visual observation. For a number of reasons, this cannot be achieved in rotary kilns and so the vertical kiln has been an object of intensive research. It promised to become possibly the first fully automatic sintering unit to be operated by remote control from a laboratory panel, without even a television set necessary to observe flow in the kiln or cooler. The research objective was to perfect accuracy of proportioning, and uniformity of raw materials and fuel sizing to such extent that eventually full atuomation of the sintering process might become feasible.

2. In 1947 introduction of the pan type nodulizer opened up such possibilities. The nodulizer enabled embedment of fuel particles completely in the raw meal thus opening the way to use of highly volatile fuels and bringing particle size of fuel and raw material into the same range.

3. The use of highly volatile fuels greatly improves uniformity of sintering by an exceptionally fast rate of heat transfer. This was learnt in large scale experimental work carried out during the last war to fire a modernized vertical kiln with heavy residual oil. Feed to this kiln was produced in a Krupp Excenter rolling press, producing ½ in by 1 in diameter cylinders, while the fuel oil was pressure-atomized and inserted into the kiln with a controllable amount of primary air. Recirculated flue gas in a countercurrent stream to the main air flow was introduced upwards from the bottom of the kiln. These experimental runs proved the soundness of the countercurrent air/gas stream principle. Later, three more kilns were converted to oil firing, based on results achieved from the experimental run with the first kiln over a period of one and a half years. Even after operating the four kilns with oil firing for several monthes, however, production still had to be regarded as in the experimental stage, mainly on account of problems arising from recirculation of hot flue gas.

4. The large scale oil firing experiments with the vertical kiln proved one important principle which later led to more improved kiln design - the increase of high temperature gas flow, involving high velocities and great pressure drops, improves the uniformity of heat

transfer in the sintering zone. This result shook the shaft kiln principle to its foundations, as earlier it was believed that the shaft kiln can only operate on high fixed carbon fuel, such as coke. However, every coke particle embedded in the material ignites and burns like a little sun, radiating heat to the material surrounding it and producing a gas flow of CO and CO_2 to move through the voids and pores. In such a process, radiant heat transfer from the glowing particle plays an important part and thus it is unavoidable that the raw material layers in the immediate vicinity of these particles are heated to a higher temperature than the layers farther from it. Furthermore, the fuel particle changes into ash which, chemically reacting with the closest raw material layer, forms eutectics at lower temperature than necessary for clinker sintering. Also high carbon fuels without an appreciable amount of volatiles, may produce local reducing atmospheres with disturbing influences on the crystallographic composition of clinker, as shown later.

5. Although recent attempts to reduce the size of the fuel particles by intergrinding with the raw material have brought great improvements, even better uniformity of temperature in the sintering zone can be achieved with a fuel, or blend of fuels, with a higher volatile content. With such fuel however, it is essential to produce absolutely uniform sized nodules and the sizing of the fuel particles must be as close as possible to the sizing of the raw meal. The good uniformity of the chemical composition of the raw meal and fuel-ash is of particular importance if the volatile content of the fuel rises higher.

6. If nodules of the right size are produced in the nodulizer, the temperature differential between the surface of the nodule and its core may reach 500 deg C. Thus each nodule is surrounded with a fast flowing stream of hot gas and air and the volatile matter in the fuel, reaching escape temperature while still in the nodule core, will ignite as soon as it joins the hot stream within the voids formed by the nodules.

7. With increased fineness of fuel there is also a marked increase of the chemical reaction between the fuel particles and the carbonates of the raw meal:- $CaCO_3 + C \rightarrow CaO + 2CO$. Thus, to a certain extent, oxidation of the fuel can start independently of air supply and this also contributes greatly to uniformity of sintering.

NODULIZER

8. The blend of pulverized raw meal and fuel is fed on the rotating nodulizer pan while a controlled amount of water is added through sprays. A rotating scraper keeps the pan clear to keep the active nodulizing surface constant. The nodules overflow through a stepped rim into a rotating spreader and then into the kiln.

9. The pan type nodulizer was introduced into the cement industry in Switzerland in 1947, and three years later in Australia. Since that time, the importance of this machine for a great variety of industries has been widely recognized all over the world. The superphosphate industry also realized the value of agglomerated dust-free fertilizer, and followed suit in all the major superphosphate works in Australia, by the introduction of nodulized superphosphate using the pan type nodulizer.

10. Experimental work is conducted in many fields of mining and metallurgy for the agglomeration of material, with a view to simplification of heating processes by the feasibility of economical

agglomerating by the new nodulizer.

11. The original nodulizer was not a success, in spite of several years of preliminary experimental work preceding the first application in 1947 in a Swiss plant. During the experimental period, the best result the nodulizer could achieve was a blend of nodules of varying size with moistened, deformed material.

12. The first plant that produced nodules of acceptable quality, in western Switzerland in 1947, was operating on dry, pre-mixed, raw meal and coke breeze to feed a kiln sintering portland cement clinker. However, even this nodulizer was far from perfect - material built up on its pan, and numerous other shortcomings impaired its performance. A considerable number of other experiments were carried out, concerning the most suitable angle and speed of the nodulizing pan and position of inlets for pulverized material and water.

13. A great variety of designs for automatic scrapers has been tried in Australia and overseas and here again, the most suitable type of scraper depends a great deal on the physical characteristics of the materials, since some pulverized materials produce extremely hard coatings on the pan; others behave differently. Application of scrapers has improved nodulizer performances to such an extent that with up-to-date machines, excellent nodules of uniform size can be obtained in nearly fully automated operation.

14. Over several years, large scale experiments were carried out with a rim extending the nodulizer pan. The most important data in this connection were received from Japan, covering the results of experimental operations with a nodulizer rim. It could be proved that application of the rim in feeding vertical kilns, sintering portland cement clinker, had eliminated completely any fine material from the nodules and had thus further improved uniformity of nodule size.

15. The nodulizing characteristics vary greatly with the different physical natures of the raw materials; their fineness is also of great importance. During the preliminary work preceding the introduction of the nodulizer into industrial practice, laboratory methods were devised to test the physical characteristics of the raw materials. The most suitable tests to check whether pulverized materials possess acceptable nodulizing characteristics, were established to be the following:-

(a) Formation of small pea-size balls from the pulverized material moistened and subsequently dried at 500C. Tests were made for mechanical abrasion and strength, either by vibrating on a suitable screen for different periods and measuring the wear loss, or by drop tests from different heights.

(b) Forming nodules in the laboratory with optimum amount of water, subjecting these nodules to consecutive drying and storing in air of defined moisture content and measuring moisture absorption and desorption. The figures so obtained proved to be an important guide for judging nodulizing characteristics.

16. Laboratory experiments proved that porosity of the nodules after drying has an important bearing on their physical properties during preheating at higher temperatures. Above a critical porosity, nodules show a tendency to crack up during the preheating process. It appeared that a certain minimum porosity is required to enable nodules to keep their shape during preheating and sintering. This minimum porosity varies, depending upon the type of material and its fineness.

17. Great progress has also been achieved during recent years in the mechanical perfection of the nodulizer. Completely enclosed gear boxes with silent gear transmissions, attached to the back of the pan, simplified designs, thus rendering the new nodulizers robust and non-sensitive, to assure long, reliable service.

18. FIGURE I shows cross section of the kiln and temperature chart. The rates of the feed of nodules into the kiln and the discharge of clinker through the rotating grate are the same so that the top material level in the kiln remains unchanged. The material in the kiln is moving down at a uniform rate of 4 ft 6 in per hr, corresponding to an output of clinker of 200 tons in 24 hours from one kiln. The air is moving upwards, so that the nodules moving downwards are getting hotter and hotter until the temperature is sufficient to ignite the coal particles incorporated in the nodules, producing the hot zone. Because of the excellent heat transfer rate, the temperature increase on a 3 ft kiln length is greater than 1360 deg C (from 100° C in the flue gases to 1460°C in the hot zone as indicated).

19. In the area above the hot zone, there may be an oxygen deficiency in the gases which may cause fuel particles in the nodules to reach temperatures at which their volatile matter may escape but, because of the shortage of oxygen, they may not fully ignite. Therefore secondary air must be provided in the area above the hot zone to supply oxygen for the combustion of the volatile matter that has reached escape (and ignition) temperature.

20. During 1957-58 large scale experimental runs were made with two kilns, using bell shaped cones from heat resistant castings to introduce air from the top of each kiln in a countercurrent stream to the main air flow coming up from the bottom; this is based on principles, referred to earlier, that were applied in the oil-fired vertical kiln. A great number of problems had to be solved in connection with this application. The accuracy required for proportioning and nodulizing was greater, asthe balance between air temperature and ignition temperature of volatile matter must be nearly perfect. Several months of experimenting were necessary before air introduction from the top operated successfully. There is however a 30% reduction in kiln output due to the smaller cross sectional area available in the sintering zone.

21. A much better method for the protection of volatiles in coal from premature escape without combustion is the coating of nodules, having the correctly proportioned coal content interground, by "white" meal, which has no coal content. By this method the output of the kiln is not reduced, as the cross sectional area of the hot zone remains intact, while due to more efficient combustion, fuel consumption is reduced by up to 20%. The combination of the coating process with the Spohn grate and the use of high volatile fuel opens up the way not only to a fully automated sintering process but also to a new method of cement clinker manufacture of unsurpassed efficiency and reliability.

22. Research work connected with this new vertical kiln required extensive studies and experimental work on porosity, gas flow in pores and voids, ignition of coal, ignition of the various groups of volatile matter, convective heat transfer from turbulent flowing gas to material surface and radiant heat transfer from flowing fuel particles to their immediate surroundings.

23. For the study of the various stages of preheating, a sampling

pipe was designed. This pipe was made by fitting two halves together, hinged on one side and with a sharp tip. It is pushed into the kiln from the top, then the two halves are opened, turned around and closed again so that the pipe withdraws from the kiln a representative cross-section of the various phases of preheating and sintering.

224. Bringing fuel particle sizing closer to raw material sizing presented many problems. The great advantages of finer fuel particles were recognized long ago as a possible contributory factor towards progressing with the vertical kiln; however, before the introduction of nodulizing and with the type of discharge equipment available 20 years ago, uniform operation of the kiln with finely ground fuel could not be achieved. But in 1955 Dr. E. Spohn introduced a new conical grate that brought the problem of using finely ground fuel much nearer to solution. Supported by excellent laboratory and large scale proving facilities, Dr. Spohn achieved uniform discharge of loose pea-sized clinker.

25. Finely ground fuel produces porous clinker in nodulized form, which cools almost in an air quenching fashion. The comparatively slow cooling of the old type vertical kiln cement clinker was regarded as a serious disadvantage, with full justification. It is well known that $3CaO.SiO_2$ crystals, formed by suitable heat treatment, can disintegrate into free CaO and $2CaO.SiO_2$ under various influences, notably slow cooling or cooling from an overheated state under chemically reducing conditions. The vertical kiln using finely ground fuel does not permit such disintegration because of porosity and consequent fast cooling of sintered nodules.

26. Table 1 shows the heat balance of the vertical kiln at a plant in Traralgon, Australia. The fuel consumption is very low in relation to conventional rotary kilns as operated in Australia; on the other hand the figures also show possibilities for important further improvement. Radiation loss through the kiln shell is still very great, thus pointing to the necessity of improved insulation, which modern vertical kilns can offer because their operating conditions have very little influence on the lining. It is not uncommon to have such kilns operating at maximum output on one lining for two years or more.

27. Important research work during the last four years has proved that heat loss from a vertical kiln is greatest in a material layer up to 4 in. from the kiln lining; it is also in this layer that sensitivity to disturbed temperature balance is greatest. Dr. H. Eigen refers to kilns that through complete insulation, consume less than 700 cal per kg of clinker. Very good results were also achieved with insulation of modern vertical kilns in Japan.

28. To achieve the accurate proportioning of fuel and raw material for the purpose of grinding these constituents together, a mill which retains the raw material and fuel particles in the grinding process only until the particle sizes reach the required level is most suitable. This is achieved by air carrying particles at this stage out of the mill through a rotating classifier into the discharge system.

29. A cement works in Isa, Japan, has successfully replaced air by kiln flue gas for the operation of mills of this type thus solving also an important problem of dust collection. This approach is quite possible if the alkali content of the raw materials is low. If, however the alkali content in the raw materials is high, the kiln

TABLE 1

HEAT BALANCE CALCULATED FOR 100 LB CLINKER

Heat input B.t.u. per 100 lb		Heat consumed B.t.u. per 100 lb
	For evaporation of water	36.300
	Decomposition of carbonates	91.629
	Loss of heat carried by CO_2 of raw meal	5.540
	Loss of sensible heat in exit gases	16.310
	Loss of sensible heat in clinker	5.400
	Loss of sensible heat in dust	.200
	Loss of some volatile matter and $CO+H_2$	8.331
	Radiation loss through kiln shell	29.931
18.000	Exothermic reaction	
.110	Organic matter in raw meal	
175.531	Heat carried into process by fuel	
193.641		193.641
	Theoretical heat requirement for 100 lb clinker:-	
	Decomposition of carbonates	91.629
	Less exothermic reaction	18.000
		73.629
	Efficiency	38%

gases will carry out most of the alkali. Any collected dust from these gases must therefore be disposed of to utilize the advantage of vertical kiln cement having very low alkali content. This advantage arises as a result of the high velocity of flue gases escaping from the hot zone into the atmosphere.

30. The above results of intensive research work in Australia, Europe and Japan have led to continuous improvements in the design of vertical kiln plants. The main problems are: accuracy of proportioning of fuel and raw material, controlled supply of air, fine grinding of raw meal and coal to prevent any marked differences in their sizing and uniform chemical composition.

31. The best method of controlling consistency of chemical composition is to work by the lime saturation method, and not titration of raw meal. According to this method raw meal sample and a measured amount of CaO are completely sintered under controlled conditions and the surplus CaO determined.

32. Many of the problems involved in perfecting modern vertical kiln

techniques are still very new and require further experimentation, as even the best ideas put into practice require some time before simple, ordinary routine operation may emerge.

33. Precision proportioning equipment for meal and coal (briquette dust is operating at present in the Traralgon plant previously referred to. After blending to the required chemical composition the meal is conveyed into a 20-ton capacity feeder hopper, the level of which is kept constant by a gauging device. The meal from this hopper flows through a variable speed cell feeder into the meal proportioning unit; this arrangement has eliminated the danger of floodings. The proportioning units for meal and fine coal were carefully selected and meet the demands for the required accuracy.

34. To operate the new vertical kiln with pulverized inter-mixed fuel must be an astonishing experience to all who had practice with the older type vertical kilns designed in the early 1950's. Manual work with iron bars is a matter of the past as are blow-outs or unevenness of operation. The kiln is completely silent; the "fire" i.e. progress of ignition of fuel particles, cannot be heard. All that has to be watched are the instruments and the nodule level in the kiln which must naturally be kept constant; i.e. feed and discharge rates must be in perfect equilibrium. Automation of this feature of kiln operation is also studied, and if constant level keeping is automated, no personnel would be required on the kiln platform.

35. The Gippsland Cement Co. operating with two vertical kilns is now producing at a rate of 400 tons per day. In March 1962 an all time record of 10,500 tons of clinker were produced. Peak production capacity from one kiln was 211 tons/24 hours. Total cost of plant including buildings, land etc. was £A1,200,000 or £A10 per ton annual production. At present 4 different brands of cement are manufactured: Normal Portland Cement "N", High Early Strength Cement "D", Sulphate Resistant Cement "R" and Masonry Cement "S" All brands are subjected to extensive testing not only in the Company's own laboratories but also in government testing institutions whose representatives can enter the plant unannounced for sampling at any time. Their tests of "N" Portland Cement prove not only absolute uniformity but also very sound quality figures, including conformity with the A.S.T.M. autoclave test requirements. The strength of "N" Cement is about 100% higher than required by Australian Standard Specifications while the results of "D" Cement are also consistently higher than required by A.S.T.M. high early strength standards. The decision to keep strengths very much above the required levels was motivated by the desire to overcome prejudice which is unavoidable if a new process, originating from the oldest process of cement manufacture, is trying a break through to prove its value by low cost, highly economical plant.

36. Establishment of cement manufacture on a relatively small scale which the new methods entail, must have a tremendous bearing on the improvement of standard of living in under developed areas.

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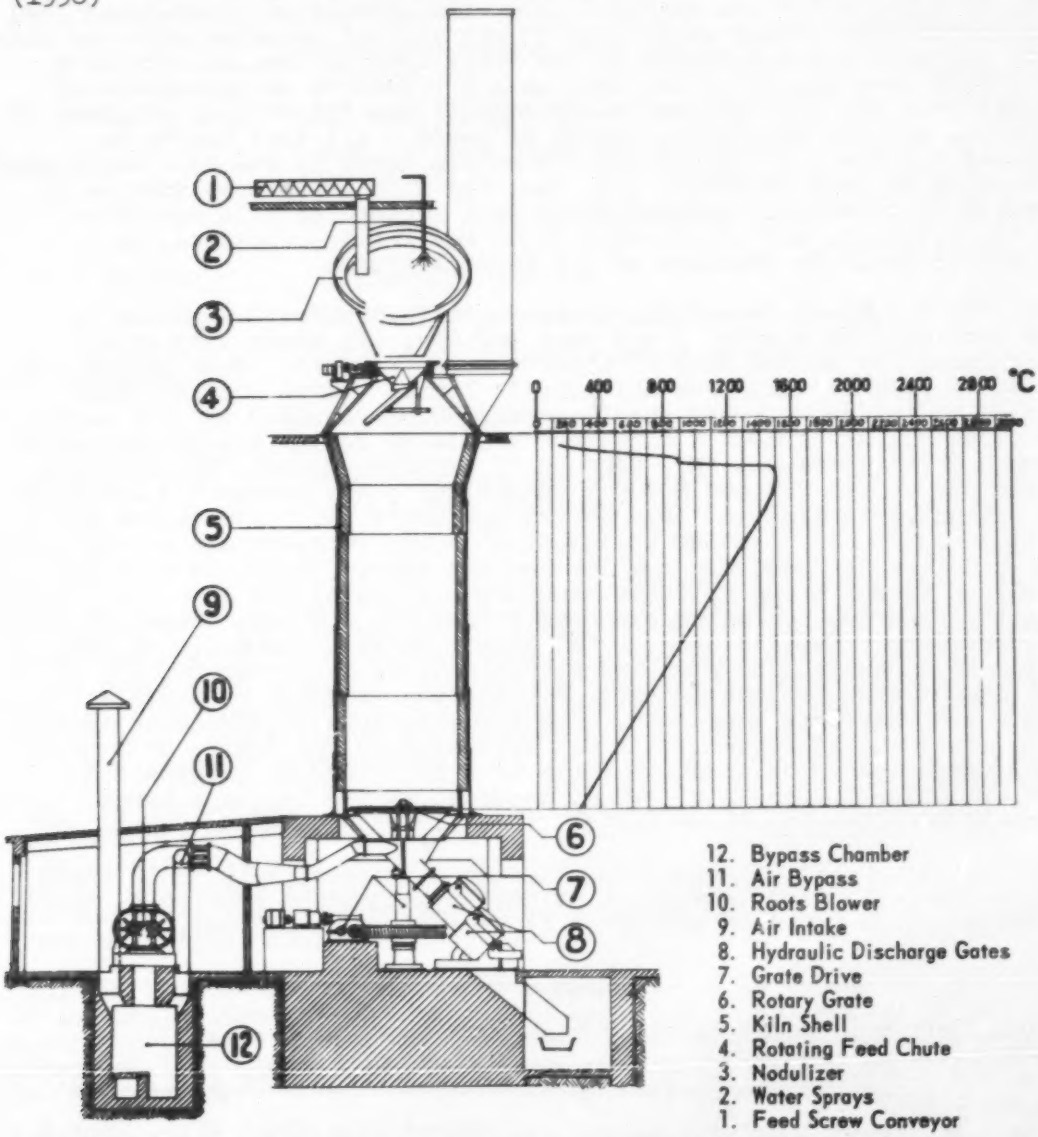

FIG. I. - Cross section of a vertical cement kiln with temperature chart in deg C. Major items of equipment are shown 1. - 12.

1373 E - Nov.1962 - 1,600

E/CONF.39/D/137
SUMMARY
26 Oct.1962
ORIGINAL : ENGLISH

UNITED NATIONS CONFERENCE
ON THE APPLICATION OF SCIENCE AND TECHNOLOGY
FOR THE BENEFIT OF THE LESS DEVELOPED AREAS

SUMMARY

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NEW VERTICAL KILN PROCESS FOR CEMENT MANUFACTURE

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Intensive research during the past years has brought the new vertical kiln into a very promising stage of development. However, even more interesting appear to be its chances for further progress. Although research workers do not like to think in terms of "practical" results (as the bridge between theory and practice is not easily found), some of these results are already worth mentioning.

First of all, the new kiln makes it economically possible to establish cement manufacture on a small scale. Conventional cement manufacture, involving several varieties of the rotary kiln, costs to-day between £25 to £30 per annual ton to establish. Therefore, a plant to produce 100,000 tons per annum would cost between £A2½ million and £A3 million to build. As under Australian conditions, capital has to earn about 20% to cover tax, depreciation and interest or dividend, 100,000 tons per annum production would carry a financial overhead of about £5/ton before spending on actual production and operating overhead. The main reason for the high capital expenditure is that the kiln and its auxiliaries involve high cost firing and heat exchange equipment.

A modern vertical kiln plant can be established at much lower cost as it is its own heat exchanger, operating mainly on convective heat transfer.

Since the low cost plant makes possible the establishment of cement industry on a relatively small scale the industry may be effectively decentralized as to capital cost, output and plant area. This is of great importance for a heavy, bulky commodity like cement, the handling and transport of which is costly and out of proportion to its value.

The second important point is the possibility of automating the sintering process fully, independent of any visual control of fire.

Thirdly, the new vertical kiln can operate on low grade fuels which are available in abundance all over the world, whereas bituminous high grade coals are scarce. Thus plants can be provided in areas of dense population or industrial promotion centres to produce the basic materials for modern building, as well as employment, where they could not have been established before. Gippsland in Australia, is an example, but there are others too. For instance, in India densely populated, often famine stricken, districts need new industries for employment to reduce the incidence of catastrophies in the future. Naturally, cement is also needed that the areas may progress and the standard of living raised.

Fourthly, the quality of the cement clinker produced in the vertical kiln is very high and fully uniform due to the nature of sintering and cooling, and has the additional advantage of a very much reduced alkali content. This makes vertical kiln clinker particularly suitable for the manufacture of a great variety of special cements; such as low alkali, low heat, sulphate resistant cements.

S - 1373 E - Nov.1962 - 1,600